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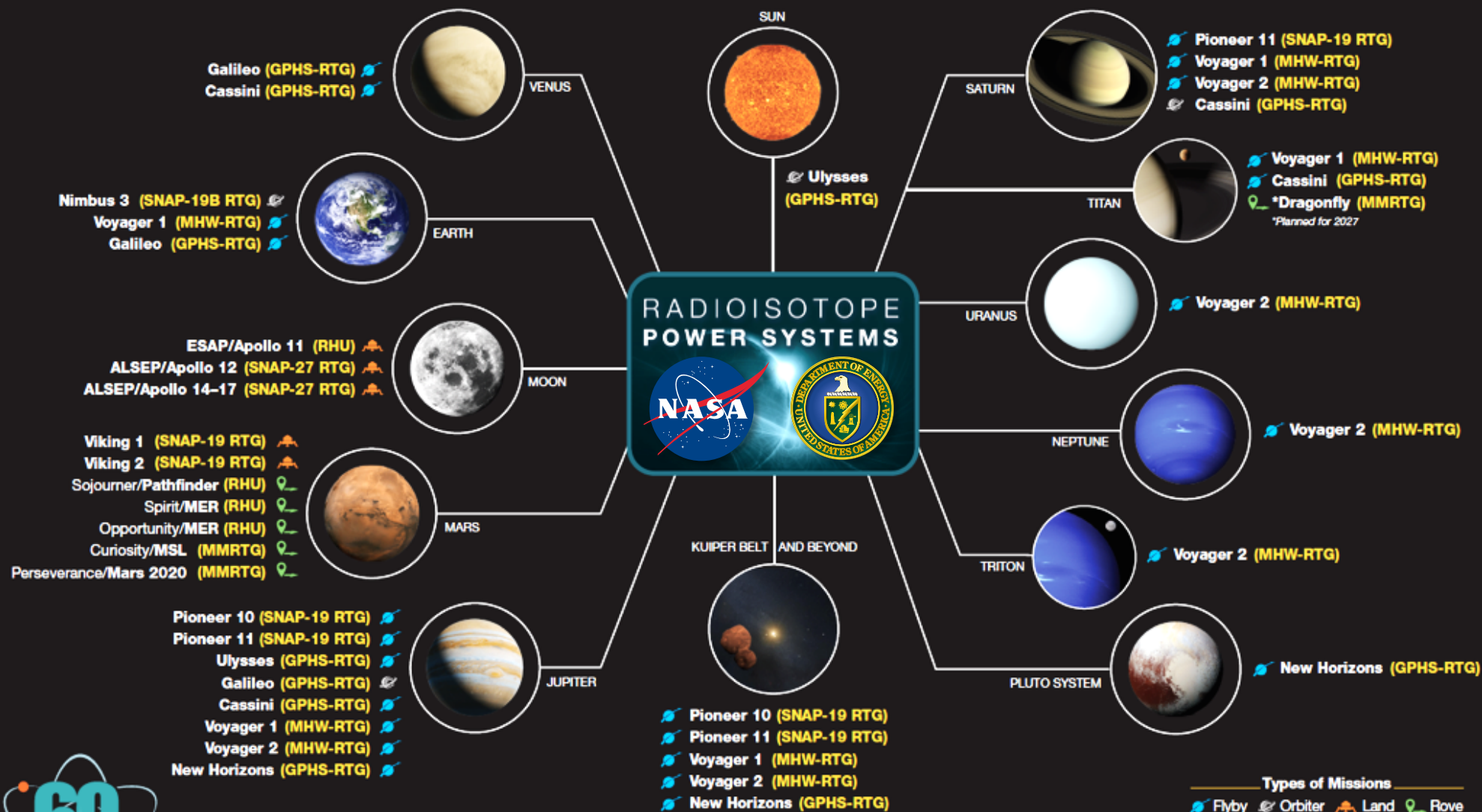
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Updated and Risk-Informed Process for Launching Space Nuclear Systems in the United States

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M I S S I O N



PROUD PAST—STRONG FUTURE

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Space Policy Directive 1

- The “Presidential Memorandum on Reinvigorating America’s Human Space Exploration Program,” (Space Policy Directive-1) charges NASA to: “Lead an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system and to bring back to Earth new knowledge and opportunities. Beginning with missions beyond low-Earth orbit, the United States will lead the return of humans to the Moon for long-term exploration and utilization, followed by human missions to Mars and other destinations.”
- Space nuclear systems will play an important role in realizing this vision.
- NASA’s long history of safe launches of nuclear power systems paved the way for the next chapter in space exploration.



National Security Policy Memorandum 20

- The “Presidential Memorandum on Launch of Spacecraft Containing Space Nuclear Systems” (NSPM-20) issued in August 2019:
 - Establishes an updated and risk-informed process for launching space nuclear systems that are funded or licensed by the U.S. Federal Government (USG), including those developed and implemented by U.S. commercial interests.
 - Was developed in consultation with U.S. space nuclear safety experts, who are cognizant of the advances in knowledge and practice gained over the last 58 years of the safe use of nuclear power in space.
 - Illustrates how the goals and guidance contained in the Principles and the Safety Framework can be implemented in nuclear safety policy.



Synergy with Standing International Protocols

- Together the Principles and the complementary Safety Framework provide sufficient guidance to States and international intergovernmental organizations seeking to develop policy to ensure the safe development and use of nuclear power in space.
- The Principles (United Nations: Principles Relevant to the Use of Nuclear Power Sources in Outer Space)
 - Non-binding, broad set of goals and guidelines including safety.
 - Intent of the specific safety goals in the Principles are fulfilled by following the implementation guidance set forth in the Safety Framework.
- The Safety Framework (UNCOPUOS and IAEA: Safety Framework for Nuclear Power Source Applications in Outer Space)
 - The Safety Framework takes the safety intent contained in the goals and guidelines of the Principles and provides practical guidance for implementation.
 - The Safety Framework general guidance enables approaches to safety based upon continuing advances in knowledge and practice. The utility of the Safety Framework is to allow for States and international intergovernmental organizations to innovate new approaches based on the expansion of knowledge and best practices gained from experience, and therefore continuously improve safety.



NSPM-20 Key Policy Tenet

- “The United States shall develop and use space nuclear systems when such systems safely enable or enhance space exploration or operational capabilities.”
 - The goals and guidance contained in the Principles and the implementation guidance set forth in the Safety Framework were considered in the development of this policy.
 - NSPM-20 is consistent with the safety intent of the Principles (Principle 3) and the guidance to governments section 3.2 in the Safety Framework.
 - Establishment and improvement of a national policy on space nuclear safety is itself consistent with the guidance in the Safety Framework section 3.1.



NSPM-20 Safety Guidelines

- NSPM-20 provides safety guidelines that are consistent with international standards and U.S. regulatory practice for nuclear facilities and activities, and provides assurance the safety guidelines are satisfied.
- The safety guidelines established in NSPM-20 apply consistently across space nuclear system types and:
 - assist mission planners and launch authorization authorities in ensuring launch safety;
 - ensure that an accident resulting in even low-consequence radiation exposure to any member of the public is unlikely, and that potential accidents that could result in higher-consequence exposures are progressively less likely;
 - are informed by comparison with guidelines developed for other previous and current nuclear activities, and are comparable to relevant U.S. standards; and
 - directs cognizant USG agencies to determine any additional guidelines that are appropriate for safe operation of nuclear reactors in space or on other planets.



NSPM-20 Safety Analysis

- The organization sponsoring a mission utilizing a space nuclear system is responsible for preparing a safety analysis report (SAR).
- When appropriate, NSPM-20 allows for the use of system-specific SARs as reference SARs to meet mission assurance requirements.
- The system-specific SAR strategy is based on a generic nuclear power system type and uses bounding estimates for accident probabilities and hazard and accident risks, and it could rely on past developed accident analysis reports if available.
- The SAR provides data that informs the level of authority for making launch authorization decisions following a three-tiered process based upon the characteristics of the system, the level of potential hazard, and national security considerations.



Interagency Nuclear Safety Review Board

- The Interagency Nuclear Safety Review Board (INSRB) is permanent group with membership from USG agencies that are stakeholders in nuclear-enabled missions.
- NSPM-20 calls for an independent review of the SAR to be conducted by the INSRB, administered by NASA, for nuclear missions that fall under Launch Authorization Tiers II and III.
- INSRB is also available to review any potential commercial launch of a space nuclear system under review by U.S. Department of Transportation.
- INSRB will review nuclear safety analyses during the mission development lifecycle in order to inform the decision to proceed with launch.



USG Launch Authorization Authority – Tier I

- Tier I applies when *all* of the following apply:
 - The quantity of radioactive material does not exceed 100,000 times the “A2 value” established in the IAEA current standards for safe transport of radioactive material;
 - Safety analysis finds that there is no credible accident scenario (less than 1 in a million chance) that might result in radiation exposure of 5 rem or greater Total Effective Dose (TED) to any member of the public; and
 - The space nuclear system is not a nuclear reactor.
- For USG missions in Tier I, the head of the sponsoring department or agency is the launch authorization authority.



USG Launch Authorization Authority – Tier II

- Tier II applies when *any* of the following applies:
 - The quantity of radioactive material exceeds 100,000 times the “A2 value” established in the IAEA current standards for safe transport of radioactive material; or
 - Safety analysis finds that there is a credible accident scenario (greater than or equal to 1 in a million chance) that might result in radiation exposure of 5 rem to 25 rem TED to any member of the public; or
 - The system is a nuclear reactor that uses low-enriched uranium fuel.
- For Tier II missions, NSPM-20 calls for an independent review of the SAR to be conducted by the INSRB.
- For USG missions in Tier II, the head of the sponsoring department or agency is the launch authorization authority.



USG Launch Authorization Authority – Tier III

- Tier III applies when *either* of the following applies:
 - Safety analysis finds that there is a credible accident scenario (greater than or equal to 1 in a million chance) that might result in radiation exposure greater than 25 rem TED to any member of the public; or
 - The system is a nuclear reactor using any nuclear fuel other than low-enriched uranium.
- For Tier III missions, NSPM-20 calls for an independent review of the SAR to be conducted by the INSRB.
- President's authorization is required for Tier III launches.



U.S. Commercial Launches Launch Authorization

- The U.S. Secretary of Transportation is the launch authorization authority for commercial launches in all three Tiers.
- The U.S. Secretary of Transportation is directed to issue public guidance describing the process that will be used to evaluate any application for a license involving a space nuclear system.
- The INSRB is available to review any potential commercial launch of a space nuclear system under review by the U.S. Department of Transportation.



Space Nuclear System Fuel Choice

- The 1992 Principles are specific that space “nuclear reactors shall use only highly enriched uranium 235 as fuel.”
- The Safety Framework provides more general guidance for implementation which allows for States and intergovernmental organizations to enhance safety based upon advances of knowledge and practice.
- The U.S. has learned through study and analysis that the safety of space nuclear applications can be enhanced by allowing for the best fuel for a given application.
- The NSPM-20 policy provides for the use of other enrichments and other fuels as a means to ensure safety.



Focus on Safety

- Issuance of NSPM-20 signals a greater degree of transparency in establishing safety policies, requirements and processes.
- Consistent with the spirit of the Principles and the Safety Framework, NSPM-20 provides the United States with an architecture for ensuring compliance with safety policies, for establishing processes to satisfy fundamental safety requirements and objectives, and ultimately for the fulfillment of safety in the use of nuclear power in space.
- NASA's history of successful launches of space nuclear systems validates many of the commonly held principles guiding governmental policy actions, mission management, and nuclear safety risk management expressed in the Safety Framework.



Conclusion

- Based on our experience with space nuclear safety practice, and in developing the NSPM-20 policy reform, the U.S. believes the safety goals and guidelines contained in the Principles are wholly reflected in the implementation guidance contained in the complementary Safety Framework.
- Together these documents provide sufficient guidance to States and international intergovernmental organizations to provide a sound foundation for the safe development and use of nuclear power in space.
- Furthermore, the more general implementation guidance in the Safety Framework allows advances in knowledge and practice to further enhance nuclear policy, and thus advances the safety intent of the Principles.

